PUNCHING APPARATUS

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Inventor:
Applicant: MARELLI & C SPA ERCOLE
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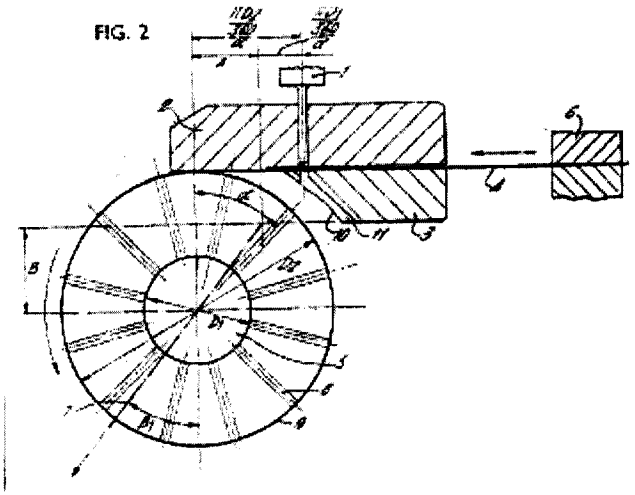
Abstract of **GB1352581**

1352581 Punching; making rotor and stator cores ERCOLE MARELLI & C SpA 14 April 1971 9432/71 Headings B3W and B3A Apparatus for making, from sheet material, such as iron strip 4, wound cores with substantially radial or oblique openings comprises a punch 1 and die 3, means for rotatably mounting a take up mandrel 5 for moving the strip through the punching station and winding the punched strip to form a core 9 and a guide surface on a block 2, against which the mandrel is urged by springs (not shown), for grinding one punched strip on to the mandrel, the mandrel mounting means allowing the mandrel to be moved away from the punching axis, as the diameter of the wound material increases, along an axis inclined relative to the punching axis to increase the spacing between the punched openings 8 and to ensure alignment of the openings in each layer of the core. In operation, the strip 4, tensioned by the clamp 6, is advanced at a rate determined by an indexing device carried by a carriage (neither shown) on which the mandrel is mounted. The device stops the mandrel for the punching of a slot 8 when the mandrel has rotated through an angle corresponding to the punching pitch. The carriage is constrained to move along a path at an angle #1 to the punching axis so chosen that, for every revolution of the mandrel, the mandrel is lowered by a distance equal to the strip thickness and displaced horizontally by a distance equal to the corresponding increment in the punching pitch.



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(72) Inventor GIUSEPPE MARINI

(19)

(54) PUNCHING APPARATUS

(71) We, ERCOLE MARELLI & C S.p.A. of Via Borgonuovo 24, Milan (Italy) a Company incorporated under the laws of Italy, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to apparatus for fabricating wound cores from sheet material. The invention has particular, although not exclusive, application to the punching of sheet iron strips and the winding of the strips into a laminated rotor or stator core for an electrical machine, the cores having slots which are radial or inclined by a predetermined angle relative to the radius.

The manufacture of these cores by some known methods have the disadvantage that the radial alignment of the slots obtained by punching in the various turns of the strip is influenced to a considerable extent by the variation of thickness of the strip due to rolling tolerances, punching burrs, etc.

The present invention proposes to minimise these disadvantages, by the provision of an improved fabricating apparatus.

According to the invention there is provided an apparatus for fabricating wound cores having substantially radial or oblique openings therein from sheet material, the apparatus comprising a punching station at which is disposed a punch and a co-operating die for punching openings in the sheet material at spaced intervals, mounting means for rotatably mounting a take up mandrel for moving the sheet material through the punching station and for winding punched sheet material to form a core, a guide surface for guiding the punched sheet material to meet the mandrel and to hold it in contact therewith at the point of entry to the winding, the mounting means being arranged to urge the mandrel towards the guide surface and enabling displacement of the mandrel away from the punching axis against the urging force with increase of wound diameter along an axis inclined relative to the punching axis to increase the spacing between punched openings and enable alignment of openings in each layer of the core.

The surface may be provided on a block through which block the punch is guided to engage the die.

A device of the type described above makes it possible for the strip to be guided to meet the mandrel, and subsequently previously wound layers of the core, tangentially so that the distance between the point of tangency of the strip on the mandrel or core and the punching axis can be reduced to a minimum. In this way the variation of thickness of the strip and of the portions of the core between these two points is negligible.

The invention will be more easily understood and various other features of the invention may become apparent from a consideration of the following description.

The invention will now be described by way of example only with reference to the accompanying drawings, in which:—

Figure 1 is a sectional detail view of an apparatus constructed in accordance with the invention at the commencement of the punching operation;

Figure 2 is a sectional view similar to Figure 1 showing the apparatus in the course of the punching of a strip to form a laminated core with radial slots, and,

Figure 3 is a sectional view similar to Figures 1 and 2 showing the apparatus in the course of the punching of a strip to form a laminated core with slots inclined relative to the radius of the core.

Figure 1 illustrates in diagrammatical section a punch 1; a guide block 2, a die 3; a sheet metal strip 4 to be punched and wound into a roll; a winding mandrel 5, and a clamp 6.

The winding mandrel 5, shaped in accordance with a spiral with radial increment over an arc of 360° equal to the thickness of the sheet iron to be punched, is mounted on a carriage (not shown) which carriage is movable along a guide inclined at an adjustable angle and relative to the axis of the punch

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and which permits translational movement of the rotational axis of the mandrel along an axis 7. The mandrel 5 is urged towards the block 2 by the mechanical action of springs (not illustrated in the drawings) so that the surface of the block meets the mandrel tangentially and the strip is held constantly in contact with the surface during the punching and winding operation.

The winding mandrel is connected to an indexing device (not shown) for controlling the rotation of the mandrel in a series of steps.

The operation of the apparatus described for producing radial slots is as follows.

The sheet iron strip 4, attached to the winding mandrel 5 and tensioned by the clamp 6, advances as the result of the intermittent rotation of the winding mandrel 5, at a rate corresponding to the punching pitch and determined by the indexing device carried by the carriage of the mandrel 5.

The indexing device (not visible in the drawings) is so controlled as to stop the rotating mandrel 5 every time the mandrel rotates through an angle corresponding to the punching pitch and for the period of time necessary for a punching operation.

The angle through which the mandrel 5 turns between two successive punching operations depends on the number of slots 8 punched in each turn of core 9 and is given by:

$$\gamma = \frac{360^\circ}{\text{number of slots.}}$$

The radial thickness of the core 9 increases constantly in the course of the winding as the number of turns increases. As can be seen from Figure 2, in order to obtain perfectly aligned radial slots with an increase $D_2 - D_1$ of the winding diameter (that is to say an increase

$$B = \frac{D_2 - D_1}{2}$$

of the radial thickness of the core) there must be a corresponding increment A of the pitch between the slots which is given by:

$$A = \frac{\pi D_2}{\frac{360}{\alpha}} - \frac{\pi D_1}{\frac{360}{\alpha}}$$

where:

D_2=external diameter of core;

D_1=internal diameter of core=diameter of winding mandrel;

α=angle subtended by the arc of the outside circumference;

$$\frac{\pi D_2}{360/\alpha}$$

is the required distance between the punching axis and the last point of contact of the strip with the mandrel at which point the strip is tangentially disposed on the periphery of the mnadrel.

This increment is obtained by moving the axis of the mandrel a distance A away from the punching axis. In the case of the invention this can be achieved (as can be seen in Figure 2) by directing the carriage carrying the winding mandrel at an angle of inclination β_1 relative to the punching axis such that

$$\tan \beta_1 = \frac{A}{B}$$

If in this equation the expression of A and B already indicated are inserted, the following equation is obtained:

$$\tan \beta_1 = \frac{2\pi\alpha^\circ}{360^\circ}$$

from which it is clear that β_1 is smaller than α for geometric reasons.

For operating reasons it is opportune to select $\beta_1 \leq 45^\circ$, because this reduces the component exerted by the guide block 2 on the roll, which component is perpendicular to the direction of movement of the carriage.

To sum up, for every rotation of the winding mandrel 5 there is a corresponding movement of the carriage along its guides to effect translational movement of the axis of rotation of the mandrel along axis 7 while maintaining the rotational axis of the mandrel parallel to its original position. The mandrel 5 is lowered by a distance equal to the thickness of the sheet iron strip during one revolution of the mandrel and is displaced simultaneously in a horizontal direction relative to the punch 1 by a distance equal to the corresponding increment of the punching pitch. By means of the carriage it is therefore possible to punch the slots in the strip with a variable pitch which is constantly equal to the effective development of the arc corresponding to the angle between the slots (equal to

$$\frac{360}{\text{Number of slots}})$$

on the circumference

The die 3 has a bevel 10 in order not to obstruct the mandrel 5, while a passage 11 for discharging waste material is inclined to one side.

Figure 3 illustrates the application of the invention to the punching of a core with slots inclined at an angle γ relative to a radius.

In this case the carriage carrying the mandrel is guided at an angle β_2 relative to the punching axis such that

$$\tan \beta_2 = \frac{A - \frac{\pi D_2}{360°/\sigma}}{B}$$

as can be seen from this Figure.

Owing to the fact that the distance between the point of contact of the strip with the winding mandrel or core and the punching axis is minimised it is possible to punch slots which are aligned with an accuracy not attainable with hitherto known systems.

Although only a single embodiment of the invention has been described it is obvious that numerous variations and modifications could be made without departing from the scope of the invention as defined by the appended claims. For example, instead of being mounted on the carriage the indexing device could be mounted on the body of the machine, in which case the transmission of the motion from the indexing device to the mandrel could be effected by a cardan shaft or flexible shaft transmission. Moreover, the abutment of the mandrel or its core against the guide block instead of being achieved by springs, could be achieved by a counterweight or by pneumatic or hydraulic cylinders.

WHAT WE CLAIM IS:—

1. An apparatus for fabricating wound cores having substantially radial or oblique openings therein from sheet material, the apparatus comprising a punching station at which is disposed a punch and a co-operating die for punching openings in the sheet material at spaced intervals, mounting means for rotatably mounting a take up mandrel for moving the sheet material through the punching station and for winding punched sheet material to form a core, a guide surface for guiding the punched sheet material to meet the mandrel and to hold it in contact therewith at the point of entry to the winding, the mounting means being arranged to urge the mandrel towards the guide surface and enabling displacement of the mandrel away from the punching axis against the urging force with increase of wound diameter along an axis inclined relative to the punching axis to increase the spacing between punched openings and enable alignment of openings in each layer of the core.

2. Apparatus according to Claim 1, wherein the mounting means enables adjustment of the inclination of the axis of displacement of the mandrel relatively to the punching axis.

3. Apparatus according to Claim 1 or Claim 2, wherein said mandrel is mounted in a carriage slidable along said axis and urged by biassing means towards a flat rigid surface lying in a plane substantially coincident with that of the path of travel of the sheet material through the punching station and disposed on the exit side thereof.

4. Apparatus according to any preceding claim, wherein said guide surface is provided by a block which also serves to mount the punch.

5. Apparatus according to any preceding claim, including an indexing device adapted to control rotation of said mandrel and operation of said punch such that the mandrel rotates intermittently through a predetermined angle and the punch operates during stationary periods of the mandrel.

6. Apparatus according to any preceding claim, wherein the die has a bevelled edge facing the mandrel.

7. Apparatus according to Claim 6, wherein a passage for the discharge of waste material is provided in the die adjacent the bevelled edge.

8. Apparatus for fabricating wound cores, substantially as hereinbefore described with reference to the accompanying drawings.

TREGEAR, THIEMANN & BLEACH,
Chartered Patent Agents,
Melbourne House,
Aldwych,
London, W.C.2.
Agents for the Applicant(s).

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1352581 COMPLETE SPECIFICATION
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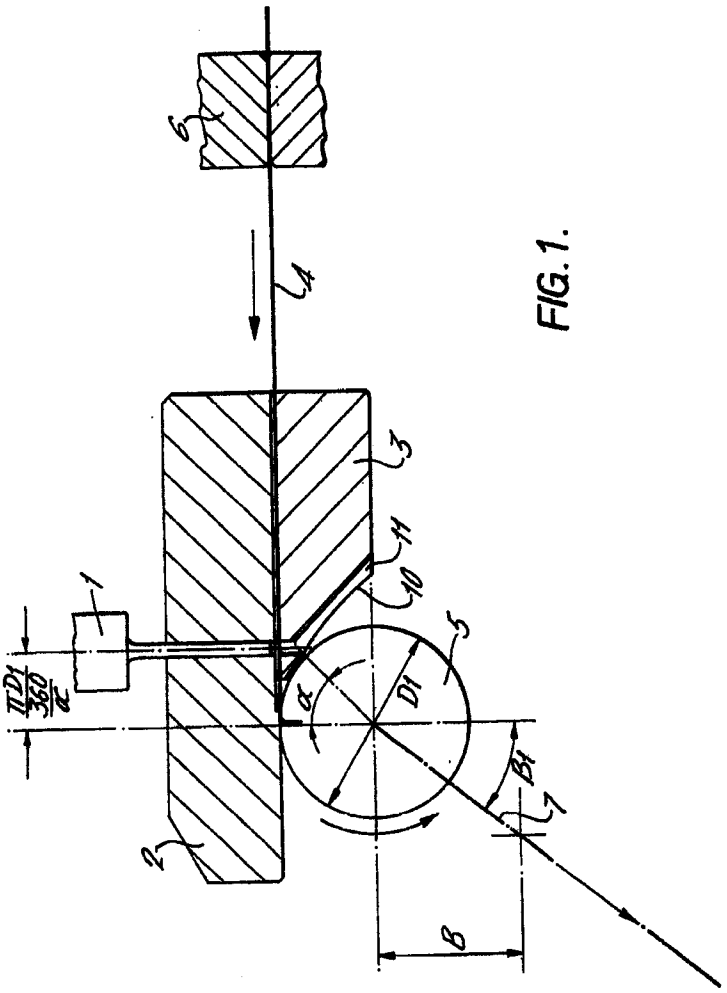

FIG. 1.

1352581 COMPLETE SPECIFICATION
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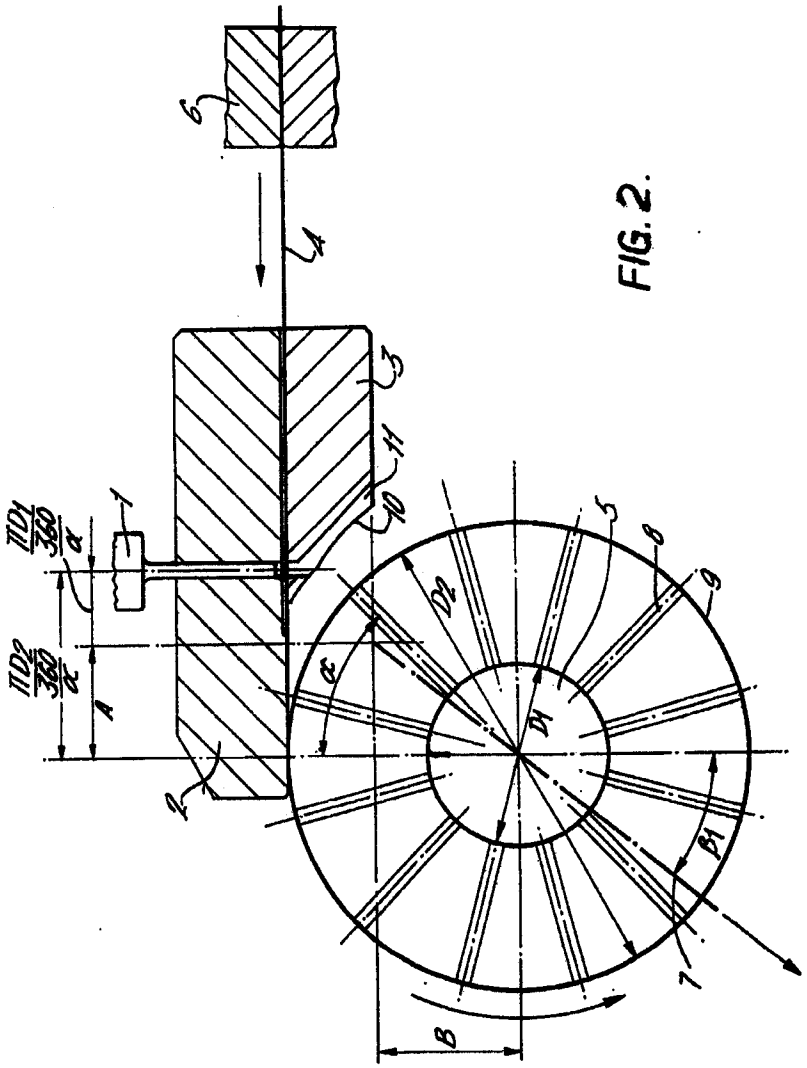

FIG. 2.

1352581 COMPLETE SPECIFICATION
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Sheet 3

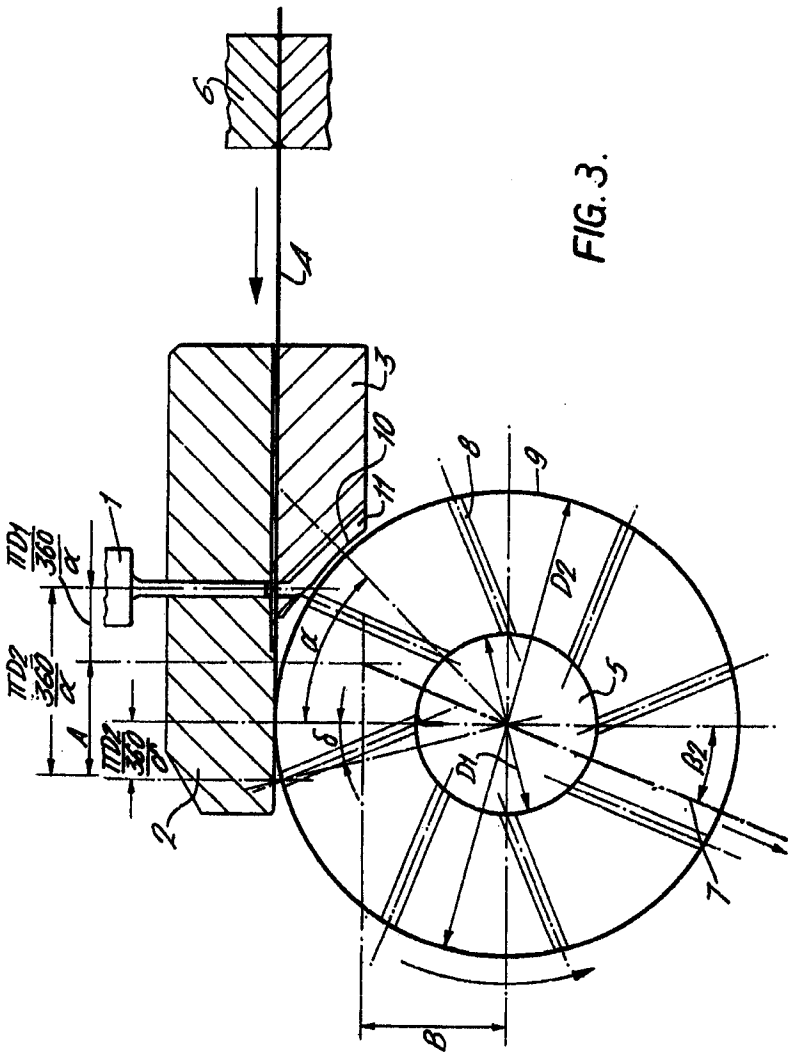

FIG. 3.